KVM 300D

GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATION
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Hipotronics inc.

applied high voltage technology for industry utilities & science

GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATION

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USER'S GUIDE

MODEL: KVM300D

PART NO. : 45-148

DANGER HIGH VOLTAGE

WARNING: This publication describes a product engineered and designed to supply HIGH VOLTAGE. Accordingly, maximum safeguards have been built into the equipment and the best safety techniques possible are set forth in the unit's operating instructions. These instructions contain cautions, warning the user to exercise great care in the use of certain controls and at appropriate points in the operating procedures. Despite these written warnings the operator of this equipment is nevertheless strongly advised to maintain a safety consciousness at all times. The following rules are particularly relevent and must be followed at all times.

BEFORE CONNECTING INPUT POWER, GROUND CASE.
BEFORE UNGROUNDING CASE, DISCONNECT POWER.

DESCRIPTION

This kilovolt meter system consists of two components - a high voltage divider and a precision readout device. These components fit inside a single durable carrying case which makes the system field portable. All interconnect and power leads are neatly stored inside as well.

The durable carrying case and battery operation make the system completely portable for field testing while the wood-grained control cabinet and divider assembly make it ideal for precision laboratory use.

The divider assembly is self contained and is a true passive voltage divider. The unit is designed to operate into a resistive load of one megohm. When used with its supplied coaxial cable a capacitive load of up to 500 picofarads can be tolerated with less than one percent accuracy change. While the divider is designed to be used with the supplied readout device it may also be used with an oscilloscope, strip chart recorder, etc. as well, keeping in mind the standard loading.

The readout device is a precision instrument designed to work in conjunction with the divider assembly. The unit is battery operated and self contained, including a charger. The many measurement modes offered by this device enable the operator to make quick and meaningful readings on various voltage waveforms. The stable circuits and digital readout provide long term accuracy.

CONTROLS AND INDICATORS

FUNCTION

D.C. The D.C. mode measures the average value of the direct current component of any voltage waveform. The digital meter will automatically indicate the correct polarity and value. The Coupling Switch must be in the D.C. position to use this mode. The A.C. position inserts a blocking capacitor in series with the signal line and therefore blocks the d.c. component.

The signal source may be a time invariant d.c. level (∿ battery) or a complex waveform that is time variant (unfiltered d.c. power supply). In any case the indicated value will be the average (over a period of ∿ .2 sec.) of the d.c. component.

ABS AV The Absolute average mode rectifies the input waveform (takes the absolute value) and then averages this value. Most universal voltmeters use this technique. This is analogous to using a bridge rectifier and a d.c. meter to measure an a.c. waveform. This mode will respond to both a.c. and d.c. components. The indicated value will be the algebraic sum of the average d.c. component plus the average value of the a.c. component, in the d.c. coupling mode. The a.c. coupling mode removes the d.c. component

RMS The Root-Mean-Square mode indicates the true r.m.s. value of any waveform. This is accomplished by means of a single integrated circuit which directly computes the rms value of a complex waveform. The converter will accurately convert signals with crest factors of up to five. (Peak value of five times the amplitude of the r.m.s. value) The r.m.s. value of a complex waveform with a d.c. component is the vector sum of the two components, i.e. $(d.c.)^2 + (RMS)^2$ The a.c. mode will remove the d.c. component from the expression. All calculations are done automatically. Note, there are no negative values in r.m.s. mode.

PEAK +, PEAK - - The Peak mode will indicate the peak values of waveform being measured. The Positive Peak mode will capture the highest or most positive excursion of the waveform even though this may be a negative polarity. Conversely, the Negative Peak mode will capture the lowest or most negative excursion. The measurement interval is averaged but over a relatively long time (5 seconds) to keep the error low.

CALIBRATION Absolute - Sine Reference

This switch provides a handy means of converting between calculated values and real values of various waveform values. Most meters are calibrated in r.m.s. but are not rms responding.

Therefore they measure in one mode and then have a conversion factor built in that relates to an rms value for a sine wave only. If the waveform is distorted or is not a sine function large errors will result.

In the Sine Ref. position the meter will indicate the equivalent r.m.s. reading based on a sine wave value but measured with the selected function. In the True position, the real value of that function will be indicated. See figure 1 for typical conversions.

COUPLING This toggle switch controls the internal signal buss. In the D.C. position there is a direct connection from the input jolt to the measurement circuits. These circuits, therefore, see the entire waveform to be measured, a.c. and d.c. component. In the A.C. position a blocking capacitor is inserted in the main signal path. This blocks the d.c. component from the measurement circuits and allows only the a.c. components to be measured. This is handy when trying to evaluate each independently such as the output of a power supply. The ripple component may be separated from the average d.c. level.

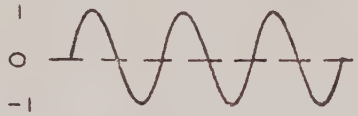
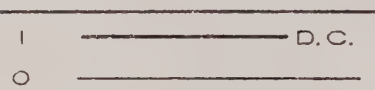
POWER This toggle switch controls the power to the main metering circuits. The illuminated digits in the meter indicate the unit is "on". The unit uses Nickel-cadmium batteries and is completely portable. This switch connects the batteries to the active metering circuitry. When the batteries are fully charged, the unit will operate for a total of eight hours before requiring a recharge. Recharge requires about sixteen hours with the unit plugged in and the Power switch off. The Charging indicator will come on when a.c. power is supplied to the charger circuits. The unit may be operated under a.c. power as well when the batteries are low or for extended periods of time.

RANGE A two position rotary switch selects a Low or High range of the meter. The decimal point will move automatically to always indicate a value in kilovolts. For maximum accuracy, the largest reading or highest deflection should be used.

O/L The Overload indicator will blink whenever the measuring circuits are overloaded and become non-linear. This is possible when measuring low duty cycle signals such as pulses. This indicates that the reading on the meter is not correct.

The meter range may be exceeded also. This condition results in the digits of the meter turning off with only the "1" left illuminated. If this happens, switch to a higher range or reduce the measuring voltage.

FIGURE 1

WAVEFORM	DC	|AV|	RMS	+PK	−PK
SINE 	0	.637	.707	+1	−1
RECT SINE	.637	.637	.707	+1	0
½ RECT SINE	.318	.318	.500	+1	0
TRIANGLE	0	.500	.577	+1	−1
TRIANGLE	.500	.500	.577	+1	0
SQUARE	0	1.000	1.000	+1	−1
SQUARE	.500	.500	.707	+1	0
D.C. 	1	1	1	1	0

EFFECTIVE VALUES OF VARIOUS WAVEFORMS

The factors shown are effective values for each ideal waveform, assuming a peak value of unity. To calculate a particular voltage, multiply the peak voltage of that waveform by its corresponding factor. This is done automatically by the readout device in the absolute (ABS) calibration mode.

The sine reference calibration mode (SINE REF) yields an effective r.m.s. value based on a sine waveform. In this position the readout will respond in the selected function, but will be calibrated in r.m.s.

OPERATION

Inspection

The unit is supplied in a protective carrying case. All necessary parts and components should be contained within this case. An inspection should be performed before use to insure all necessary items are present and in working order.

a. Place the case on the floor in the upright position. Flip upward and disengage the four over-center latches. Remove the top end cover to expose the readout device. Pull the readout device out of the carrying case. This will expose the cable compartment. This should include one twenty-five foot length of coaxial cable with BNC type connectors for interconnecting the readout device and the divider assembly. A length of braided cable is supplied to be used as a ground lead for the divider. Also, there should be a power cord to allow the readout device to be plugged into an a.c. outlet for recharging the batteries.

b. Flip downward and disengage the bottom four over-center latches. Lift the white case upward away from the base assembly. This will expose the high voltage divider assembly.

Inspect all equipment and surfaces for obvious defects. The divider should be clean and oil free. Connectors and hardware should be tight and undamaged. The readout device should be checked for battery condition. Throw Power switch to ON position. Meter digits should glow and should zero in a short time to within ± five counts. If meter light level fades or does not zero, recharge batteries with Power switch in off position.

Charging

To recharge the internal batteries connect the power cord to the readout device and plug into an a.c. outlet. The On Charge indicator will light when power is applied. A full charge takes about sixteen hours when the batteries have completely run down. This charge should last for eight hours of use.

a. The batteries can not be overcharged. The charger is self-limiting and can be left on indefinitely.

b. The unit may be operated with the charger on. This allows immediate use of a unit with low batteries and provides operation for longer than an eight hour period.

c. If the unit is to be stored for some time the batteries should be charged first. Do not allow long intervals of time with discharged batteries. This will degrade life greatly. Always turn Power switch to Off position when not in use or before storing.

Re-assemble unit in carrying case for field operation or storage.

OPERATION (CONTINUED)

Voltage Measurement

Unpack the unit and set up in the area to be used. The following guidelines should be observed;

1. A minimum area must be maintained around the High Voltage Divider that is free of all conductive articles. This area is at least a radius in all directions, except downward, equal to the height of the divider.

2. Connect the braided ground lead to the ground connector at the base of the divider. Clip the other end to a solid station ground.

3. Connect one end of the coax interconnect lead to the signal connector at the base of the divider. Connect the other end to the readout device signal input.

4. A ground lead at the readout device is optional once the divider is securely grounded. However, for maximum operator safety in the event of flashover, a ground lead should be attached to the readout device to a separate reliable ground as well.

5. Connect high voltage lead to the top toroid on the divider assembly.

6. Turn read device power on and allow one minute for stabilization. Apply high voltage. Measure as needed (see controls)

7. Shut down high voltage. Verify voltage is down on meter readout. Short high voltage point to ground. Turn meter power off - disassemble in reverse order and repack all components in carrying case.

MODEL KVM-300D

SPECIFICATIONS

Read-Out Section

Display	Digital, 3-1/2 digits, 1/2" LED Auto polarity
Range	High, 0-300 kV Low, 0-30.0 kV
Input	Impedance = 1 Megohm Level = 100 V F.S.
Accuracy	DC = ± .5% of F.S. AV = ± 1% of F.S. RMS = ± 1% of F.S. Peak = ± 2% of F.S.
Power	Internal battery, 4D size Ni-Cd External, 115/230V Operation - 8 hours, Recharge - 16 hours
Size	5"H x 10"W x 8-1/2"D
Weight	5-1/2 lbs.

Divider Section

Voltage Rating	300 kV AC (420 kVp) 300 kV DC
Ratio	3000:1 with load impedance of 1 Megohm && >500 pF
Input Impedance	1140 Megohms, 33 pF
Output Impedance	Approx. 613 k ohms, .1 uF
Freq. Response	DC to greater than 1 kHz
Size	54"H x 20"D
Weight	50 lbs.

SPECIAL OPERATING PROCEEDURES

For maximum accuracy and good reliability certain operating proceedures must be followed. These systems employ components that will measure values in the Very High Voltage class. Measurments of this type require extra care to insure protection of both operator and equipment. The following should be used as a guide when using this equipment.

a. The base of the divider must be returned to a solid ground connection. Never depend on a ground connection at the read-out device alone. Very high currents can arise from a flash-over, etc. The interconnect cable is not designed to handle this high current. Damage to the operator and equipment could occur.

b. Sharp points and close proximity should be avoided. Mechanical damage to the spinnings can cause point discharges which will result in "spitting" at high voltages or possible flash-over. A radius equal to at least the height of the divider must be kept clear around the divider during operation. Sharp points, even though at ground potential, should be kept clear of at least twice this area as well.

c. The High Voltage Divider and associated insulators must be kept clean and free of any type of cenductive material.(This includes some types of cleaning solvents) A general rule of thumb is that the guy ropes may be left in place under operating conditions of up to one half(1/2) of rated voltage. At higher voltages the guy ropes should be disconnected at the base and placed inside (on top of) the input spinning. If the guy ropes become dirty or are suspect at any time they should not be left in place during operation.

d. The High Voltage Divider is an oil filled phenolic cylinder. It houses the upper arm resistors and capacitors and is fixed to a metalic base at ground potential. Its ratio of height to diameter is high therefore nylon guys are used to help stabilize the unit mechanically. These guys must be in place and under tension whenever the unit is to be moved or transported. To do otherwise could cause excess mechanical stress in mating surfaces of the cylinders leading to fracture or an eventual oil leakage .

HIPOTRONICS

Exhibit A
SOP # 652

WARRANTY

HIPOTRONICS, INC. warrants to the original purchaser of any new merchandise that the merchandise is free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment. The obligation of Hipotronics, Inc. under this Warranty is limited, in its exclusive option, to repair, replace or issue credit for parts or materials which prove to be defective, and is subject to Purchaser's compliance with the Hipotronics, Inc. Warranty Claim Procedure as set forth below. The happening of any one or more of the following events will serve to void this Warranty and any defect or damage resulting therefrom is specifically excluded from Warranty coverage: (a) defects due to accident, negligence, alteration, modification, faulty installation by Purchaser or Purchaser's agents or employees, abuse or misuse; (b) attempted or actual dismantling, disassembling, service or repair by any person, firm or corporation not specifically authorized in writing by Hipotronics, Inc. (c) defects caused by or due to handling by carrier, or incurred during shipment, transshipment or other move.

This Warranty covers only those parts and/or materials deemed by Hipotronics, Inc. to be defective within the meaning of this Warranty. The liability of Hipotronics, Inc. shall be limited to the repair, replacement or issuance of credit for parts deemed defective within the meaning of this Warranty. Costs incurred by purchaser for labor or other expenses incidental to the inspection, repair, replacement or issuance of credit for such parts and/or material shall be the sole responsibility of purchaser. This Warranty shall not apply to any accessories, parts, or materials not manufactured or supplied by Hipotronics, Inc. and if, in the sole discretion of Hipotronics, Inc., Purchaser's claim relates to any materials or workmanship manufactured or performed by the supplier of a component part, or of the manufacturer of a device of which the defective part is a component, Hipotronics, Inc. reserves the right to disclaim liability under this Warranty and to direct that the Purchaser deal directly with such supplier or manufacturer. Hipotronics, Inc. agrees to assist the Purchaser in processing or settling any such claim without prejudicing its position as to liability.

WARRANTY CLAIM PROCEDURE Compliance with the following Warranty Claim Procedure is a condition precedent to the obligation of Hipotronics, Inc. under this Warranty:

(a) Purchaser must notify Hipotronics, Inc. in writing by certified or registered mail, of the defect claimed within twelve (12) months after date of original shipment. Said notice

WARRANTY

WARRANTY CLAIM PROCEDURE (cont'd)

shall describe in detail the defect, the defective part, and the alleged cause of defect; (b) at the exclusive option of Hipotronics, Inc., Purchaser shall dismantle or disassemble at Purchaser's cost and expense and shall ship the defective part or material prepaid to Hipotronics, Inc., Brewster, New York 10509, for inspection, or permit an authorized service representative of Hipotronics, Inc. to inspect the defective part or material at Purchaser's premises. If Hipotronics, Inc. shall inspect the part or material at the Purchaser's premises, Purchaser shall provide facilities for, and at Purchaser's cost and expense, dismantle, disassemble, or otherwise make accessible the subject part or material whether or not same is a component of or installed in a device other than that manufactured or supplied by Hipotronics, Inc. If disclosure shows that the defect is not one for which Hipotronics, Inc. is liable, the Purchaser agrees to reimburse Hipotronics, Inc. for all expense incurred; (c) upon receipt of the defective part or material, or after access to same, Hipotronics, Inc. shall inspect the part or material to determine the validity of Purchaser's claim.

The validity of any Warranty Claim, Purchaser's compliance with Hipotronics, Inc. Warranty Claim Procedure, the obligation to either repair, replace, or issue credit, or direct the purchaser to deal directly with a manufacturer or supplier are to be determined solely and exclusively by Hipotronics, Inc. and any determination so made shall be final and binding.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED ON THE PART OF HIPOTRONICS, INC., INCLUDING THE WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR USE, AND CONSEQUENTIAL DAMAGES ARISING FROM ANY BREACH THEREOF AND HIPOTRONICS, INC. NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON, FIRM OR CORPORATION TO ASSUME ANY LIABILITY OR OBLIGATION IN CONNECTION WITH THIS SALE ON ITS BEHALF AND PURCHASER ACKNOWLEDGES THAT NO REPRESENTATIONS EXCEPT THOSE MADE HEREIN HAVE BEEN MADE TO PURCHASER.

9/17/71

RETURNED MATERIAL

If, for any reason, it should become necessary to return the equipment described in this publication to the factory, the Warranty Service Department of HIPOTRONICS must be contacted, at which time the following data must be given in order that we may identify the unit and determine the necessity for return. [Tel. (914) 279-8035] MODEL, SERIAL NO. and TYPE (Part No.) is indicated on the black and silver tag affixed to the unit.

MODEL:
SERIAL NUMBER:
TYPE (Part No.):
REASON FOR RETURN:
DEFECT:
ALLEGED CAUSE OF DEFECT:

If HIPOTRONICS deems return of the unit appropriate, an "Authorization for Return" tag will be issued. This will instruct you as to the method of return. The pink copy is for your records, the hard copy to be affixed to the unit being returned. If return is not deemed advisable, other inspection arrangements will be made.

NOTE: Material received at this plant without the proper authorization shall be held as "customer's property," with no service performed until such time as the proper steps have been taken.

Your cooperation is requested in order to ensure prompt service. Thank you.

PARTS ORDERING

To order replacement parts for this unit, please refer to the Parts List contained in the pocket of this publication. The number of the specific component is required, along with the TYPE (Part No.) of the unit. The TYPE (Part No.) is indicated on your Parts List, and on the black and silver tag affixed to the unit.

AC-DC Digital KVM

Model: KVM300D
Part No: 45-148

A1	Subassembly, Read out Assembly, P/N 45-121, Hipo
A2	Subassembly, HV Divider, 45-138, Hipo
	Line Cord P2392, Switchcraft RG58/U Coax Cable w/BNC/S, 25 Feet long Ground Braid 1/2"W x 6 Feet long

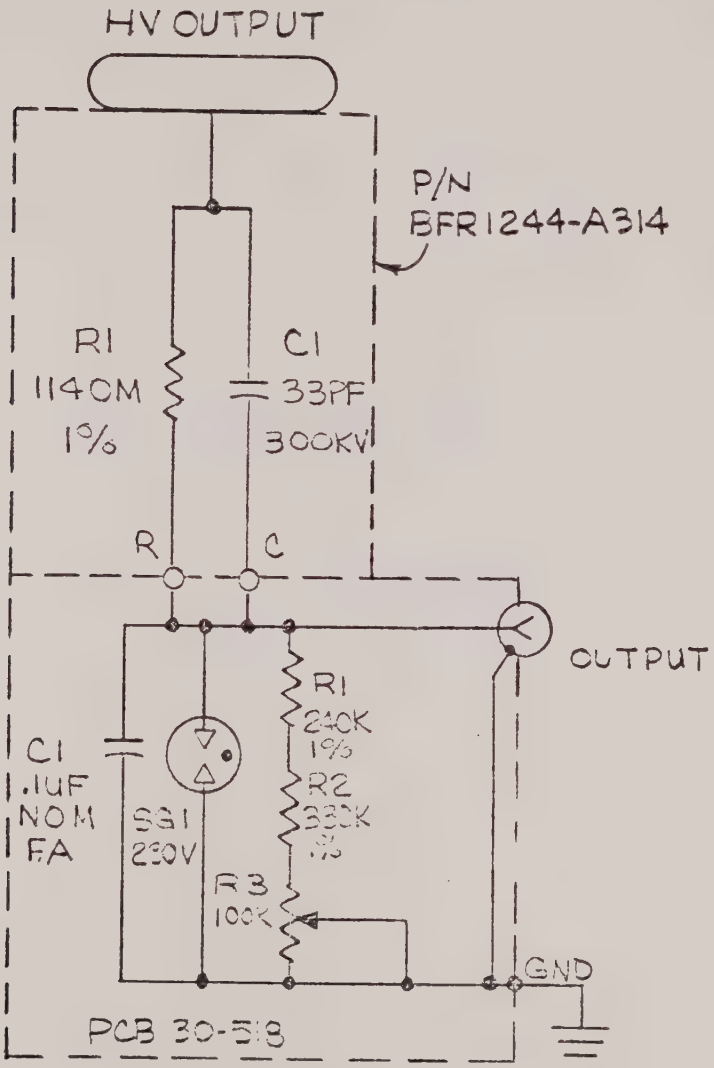
PARTS LIST

AC/DC HV DIVIDER

MODEL NO: KVM 300D
PART NO: AS45-138

A1	Subassembly PCB 30-518 Hipo
A2	Subassembly, Divider, upper arm, BFR1244-A314 HIPO Torid 5" x 20" dia alum
J1	BNC, UG1094/u
SL	Switch, Toggle, DPDT 7565K5 C & H or equivalent
A1	PCB Assembly P/NA30-518
PCB	FAB, F30-518 Hipo
C1	Capacitor, .1UF @ 400V Nom value, F.A.
R1	Resistor, 240K 1/2w 1%
R2	Resistor, 330K 1/2w 1%
R3	Resistor, POT, 10 Turn Trim, 100K, 3067P-1-103 Bourns
R4	Resistor, 1.1 MEG 1/2w 1%
SGL	Spark Gap 230v, B1FA230F Siemens

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	EC37-1730	6/32	



HV DIVIDER
3000:1
300KV AC/DC

HIPOTRONICS
BREWSTER, N.Y.

NEXT ASSY	MODEL NO KVD 300
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES DO NOT SCALE DWG TOLERANCES	DRAWN DATE 12/9/
	CHECKED 12/9/
	APPROVED 2/9/
	DWG NO. AS45-138 REV -
FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±30'	SCALE SHT OF

PARTS LIST

MODEL NO: KVM READ-OUT ASSEMBLY
PART NO: 45-121 REV B

A1	Subassembly, Main Circuit PCB Assy., P/N 30-539
A2	Subassembly, Switch PCB Assy., P/N 30-536
A3	Subassembly, Charging/Pwr. Supply, P/N 30-523
B1-4	Battery, 1.2 Volt "D" Size NI-CAD, #CH-4, Ever-Ready
C1	Capacitor, 15 uF @ 25 V
J1	Jack, BNC UG-1094/U, Amphenol
J2	Jack, Binding Post, 1-873, Nat'l Teltronics
J3	Jack, EAC-301, Switchcraft
M1	Meter, Digital, 3-1/2 Digit Series 30 Gralex
P1,2	Plug, 16 Pin Dip Low Profile Connector, 609-M-165H, T&B
P3	Plug, 5 Pin, 09-50-3051, Molex
R1	Resistor, 100 ohms, 2 W
SG1	Spark Gap, 230 V, #B1-A230F, Siemens
	Line Cord, P2392, 7-1/2' long, Switchcraft

PARTS LIST

MODEL: KVM Main Circuit Board (Digital)
PART NO: DS60-539

PCB	FAB, 30-539
C1,5,6, 10	Capacitor, 15 uF @ 25 V, Tantalum
C3,4,7-9, 11,13-15	Capacitor, .1 uF # 100 V, Mylar
C12,18	Capacitor, .1 uF @ 50 V, Disc.
C16	Capacitor, .001 uF @ 1 kV, Disc.
C17	Capacitor, .01 uF @ 160 V, Polystyrene
CR1,4	Diode, 1N4148 (or substitute CR2,3: see schematic)
CR2,3	Diode, 1N4741, 11 V, 1 W, Zener
CR5-8	Diode, 1N914
CR9	Diode, 1N4007
IC1,2	Integrated Circuit, OP, Amp LF351N (low offset)
IC3	Integrated Circuit, OPTO-FET, H11F2
IC4	Integrated Circuit, Rms Converter, AD536, Analog Devices
IC5	Integrated Circuit, Quad Op Amp, LM339
IC6,7	Integrated Circuit, OP Amp, UA741
IC8	Integrated Circuit, Quad Nand Gate, MC14011
IC9	Integrated Circuit, Comparator, LM211, (low offset)
IC10	Integrated Circuit, Sample/Hold AD582, Analog Devices
J1	Jack, 5 Pin, 09-65-1051 (w/locking tab), Molex
J2,4	Jack, 10 Pin, 22-03-2101, Molex
J3	Jack, 16 Pin, Dip Socket, LC-16, AFE
PS1	Power Supply, DC-DC Converter, EA5D15/60R, ISO PAK
R1	Resistor, Factory Adjust, 1/2 W, 10%
R2	Resistor, Factory Adjust, 1/2 W, 1%
R3	Resistor, 1 M ohm, 1/2 W, 1%
R4,13	Resistor, 950 k ohms, 1/2 W, 1%
R5,6	Resistor, 50 k ohms, 1/2 W, 1%
R6,7,15, 16,20,21, 39,40	Resistor, 330 k ohms, 1/2 W, 10%
R8,12	Resistor, Trim Pot., 10 k ohms, 3386H-001-103, Bourns
R10,41	Resistor, Trim Pot., 10 k ohms, 3069P-1-103, Bourns
R11	Resistor, 45 k ohms, 1/2 W, 1%
R14,22	Resistor, 220 k ohms, 1/2 W, 10%
R17,19, 25,27	Resistor, 10 k ohms, 1/2 W, 1%
R23	Resistor, 330 k ohms, 1/2 W, 10%
R24	Resistor, Trim Pot, 100 k ohms, 3069P-1-1004, Bourns

PARTS LIST

MODEL NO: KVM Main Circuit Board (Digital)
PART NO: DS60-539

R26	Resistor, 39 k ohms, 1/2 W, 1%
R28,32	Resistor, 47 k ohms, 1/2 W, 10%
R29,30,31	Resistor, 1 M ohm, 1/2 W, 10%
R34	Resistor, 56 k ohms, 1/2 W, 10%
R33,35,36	Resistor, 100 k ohms, 1/2 W, 10%
R37,38	Resistor, 470 k ohms, 1/2 W, 10%
R42	Resistor, 100 M ohms, 1 W, 10%
R43	Resistor, 10 k ohms, 1/2 W, 10%
R44,48	Resistor, 2.2 k ohms, 1/2 W, 10%
R45,49	Resistor, 3.3 k ohms, 1/2 W, 10%
R46	Resistor, 4.7 k ohms, 1/2 W, 10%
R47	Resistor, 1 k ohm, 1/2 W, 10%

S1C1-3,6,7, 9,11	8 Pin Low Profile, Dip Socket, LC-8, AFE
X1C4,5,8,10	14 Pin Low Profile, Dip Socket, LC-14, AFE

PARTS LIST

Switch Circuit PCB Assembly

P/N DS60-536

PCB	FAB, 30-536
J1	Not used
J2	Connector, 16 Pin Dip Low Profile #LC-16, AFE
LED1	LED, Red with Mounting Hardware #5082-4650, H.P.
P1	Connector, 5 Pin, #09-50-3051, Molex
P2	Connector, 10 Pin, #22-01-2101, Molex
R1-4	Resistor, 10 Turn Trim Pot., 5 k ohms, #3067P-1-502, Bourn
R5,7	Resistor, 12.4 k ohms, 1/2 W, 1%
R6	Resistor, 11.3 k ohms, 1/2 W, 1%
R8	Resistor, 16.8 k ohms, 1/2 W, 1%
R9,11,15	Resistor, 10 k ohms, 1/2 W, 1%
R10	Resistor, 1.1 k ohms, 1/2 W, 1%
R12	Resistor, 3.74 k ohms, 1/2 W, 1%
R13	Resistor, 10 Turn Trim Pot, 122 k ohms, #3069P-1-104,Bourn
R14	Resistor, 10 M ohms, 1/2 W, 10%
R16	Resistor, 9.09 k ohms, 1/2 W, 1%
S1,4,5	Switch, Toggle DPDT, MTA206N-WW, Alcoswitch
S2	Switch, Rotary PA2002, Centralab
S3	Switch, Rotary PA2004, Centralab

PARTS LIST

Charging/Power Supply PCB Assembly

P/N CS60-523

PCB	FAB, 30-523
C1	Capacitor, 500 uF @ 50 V, Electrolytic
CR1-7	Diode, 1N4007
F1	Fuse, 1 A, 3AG
L1,2	Choke, 2.5 mH, 200 mA. #4537, J.W. Miller
MOV1,2	Movistor, 250 V, #V250LA90A, G.E.
Q1	Transistor, NPN MJE-3055K
R1	Resistor, 100 ohms, 2 W, 10%
R2	Resistor, 2.2 ohms, 1 W, 10%
R3	Resistor, 3.3 ohms, 1 W, 10%
J1	Connector, 5 Pin, #09-65-1051, Molex
S1	Switch, DPDT Toggle #MTA206N-PC, Alcoswitch
T1	Transformer, 10VCT @ 600 mA 110/220, #LP-10-600 Signal Corp.

MP MASTER
MA35115